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**Schofield**

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(54) **DRIVER ASSISTANCE SYSTEM FOR A VEHICLE**

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See application file for complete search history.

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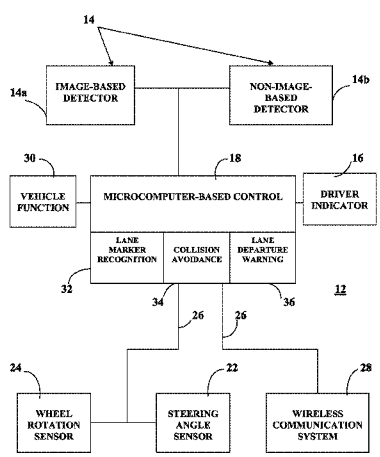
(57) **ABSTRACT**

A driver assistance system for a vehicle includes a forward facing camera and a control comprising an image processor that processes image data captured by the forward facing camera. The control receives vehicle data relating to the vehicle, including vehicle speed and vehicle steering angle, via a vehicle bus of the vehicle. Via processing by the image processor of image data captured by the forward facing camera, the control is operable to detect a road marking on the road being traveled by the vehicle and to the left of the vehicle. Responsive at least in part to processing of captured image data by the image processor, the control determines a driving condition of the vehicle, such as the type of lane markers present ahead of the vehicle, a traffic condition at or ahead of the vehicle, and/or a hazardous condition at or ahead of the vehicle.

**26 Claims, 5 Drawing Sheets**



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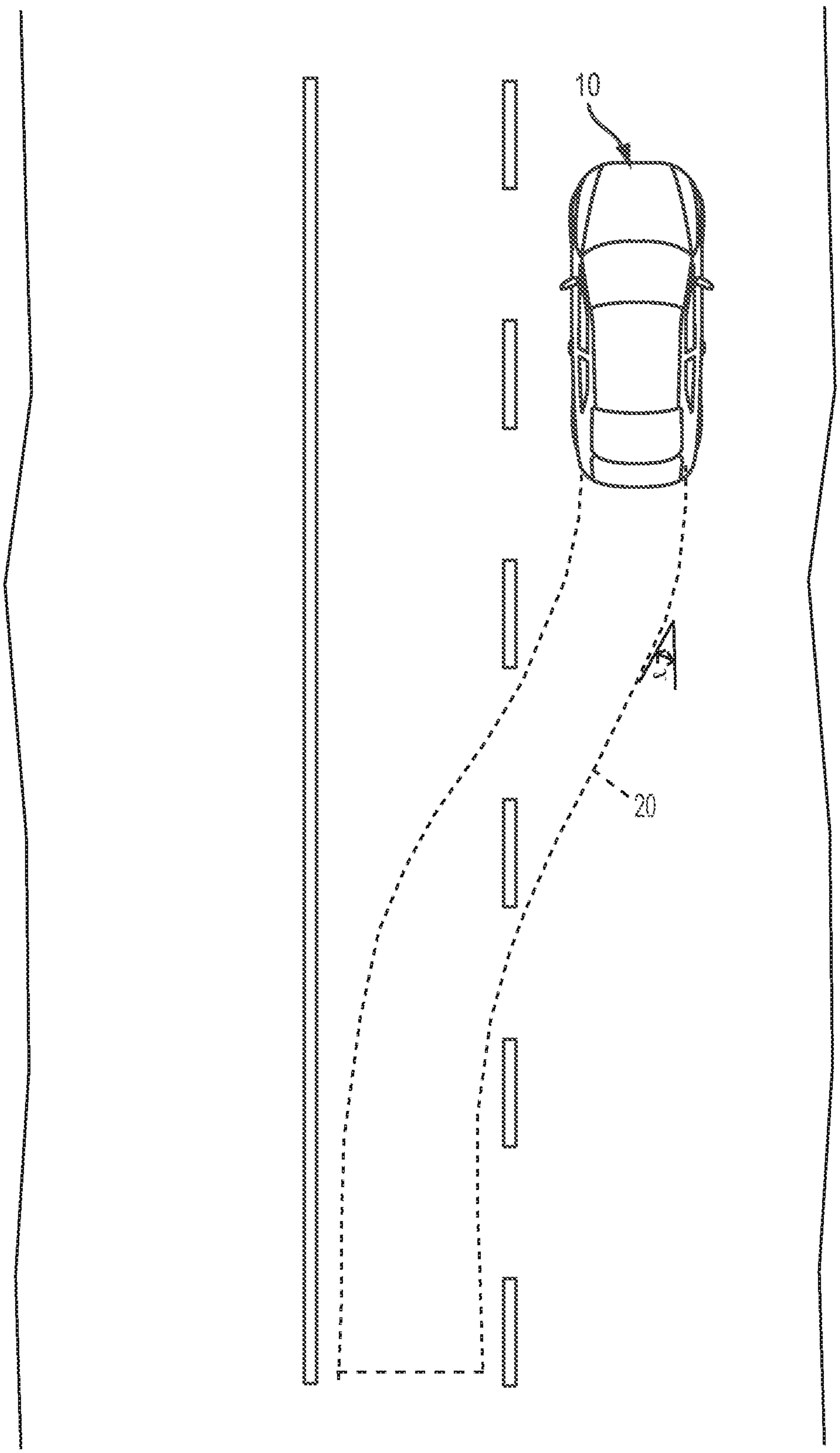


FIG. 1A

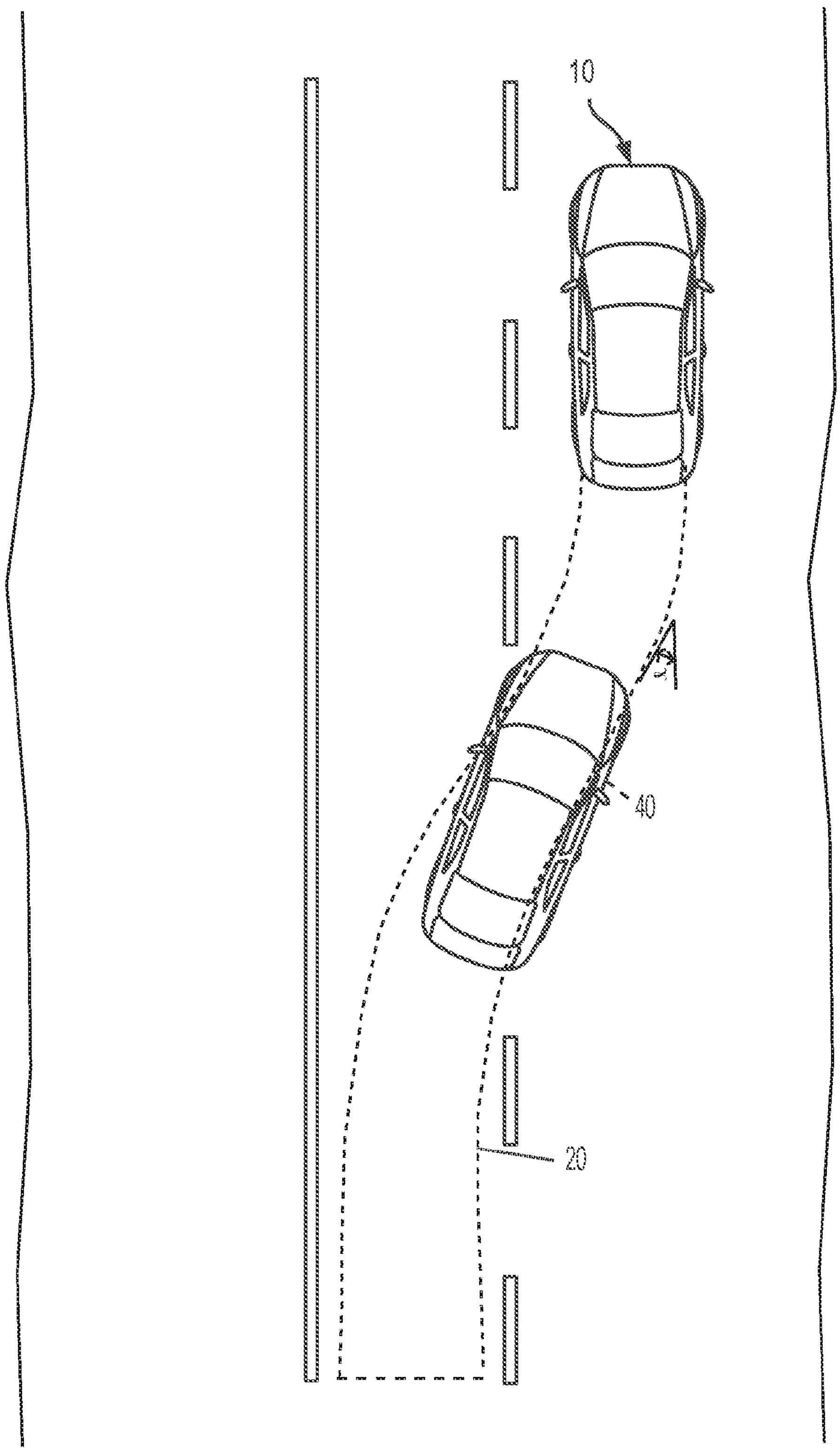


FIG. 1B

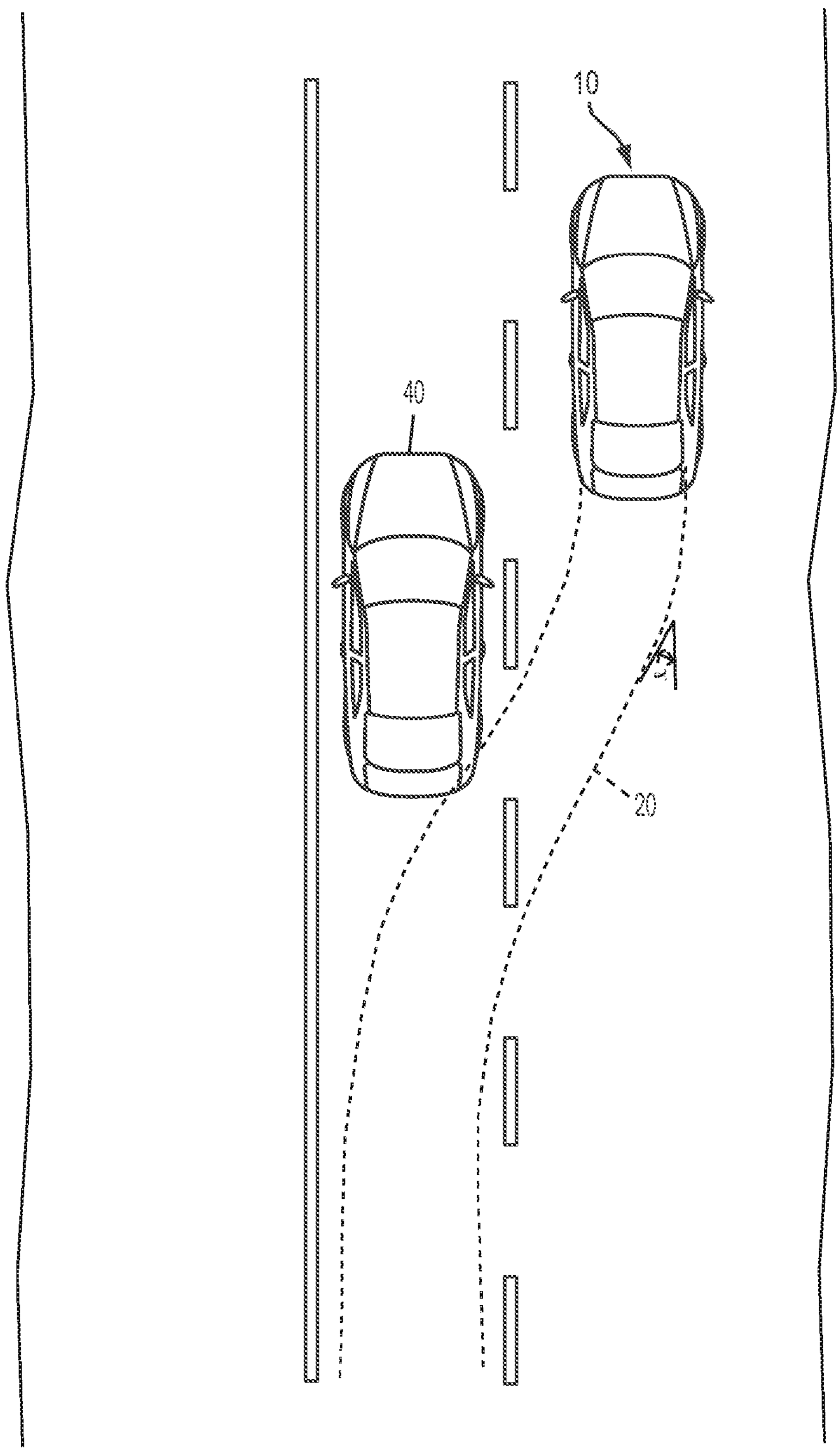


FIG. 1C

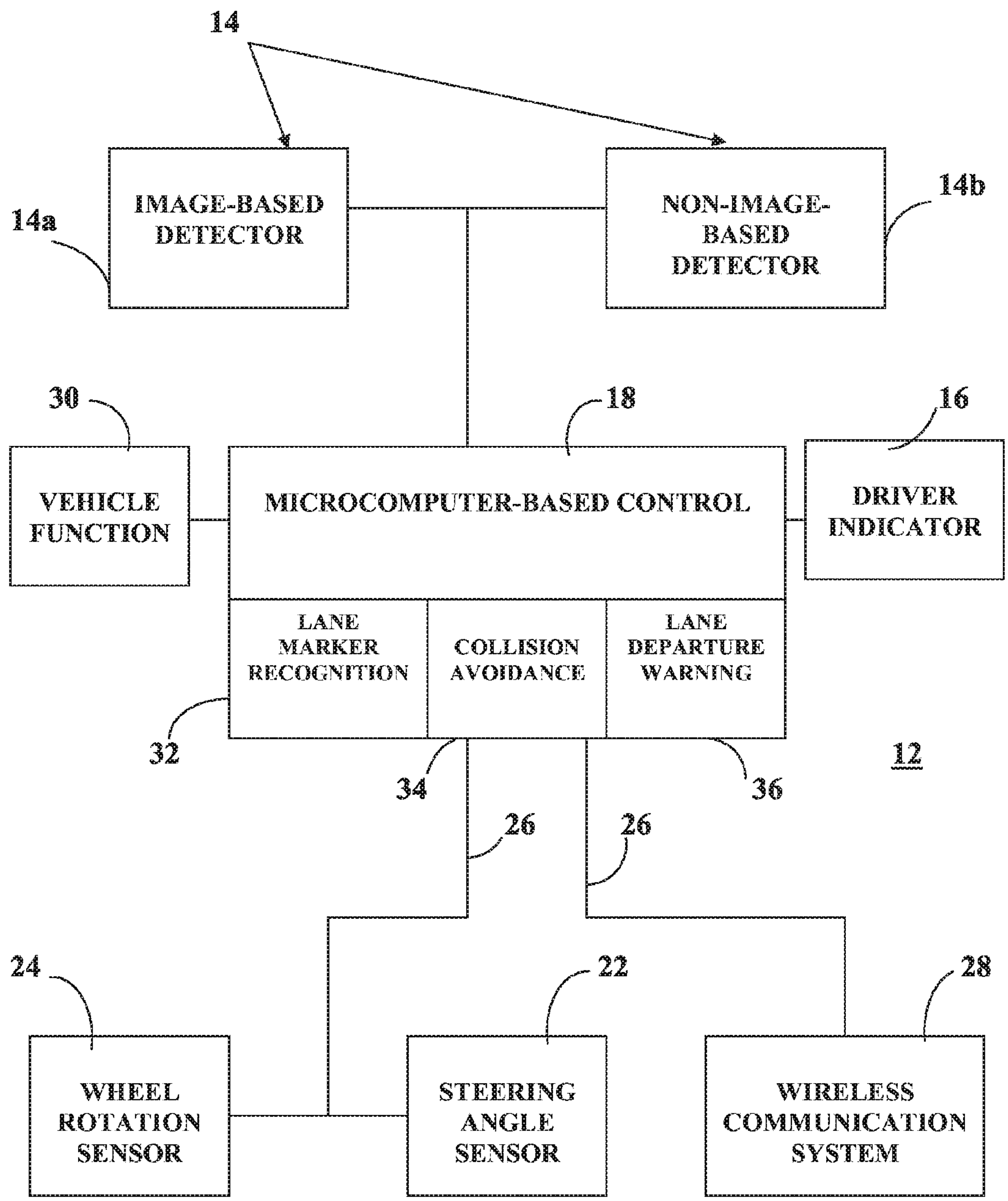
14
IMAGE-BASED DETECTOR
14a
NON-IMAGE-BASED DETECTOR
14b
30
18
16
VEHICLE FUNCTION
MICROCOMPUTER-BASED CONTROL
DRIVER INDICATOR
LANE MARKER RECOGNITION
COLLISION AVOIDANCE
LANE DEPARTURE WARNING
32
34
36
12
26
26
24
22
28
WHEEL ROTATION SENSOR
STEERING ANGLE SENSOR
WIRELESS COMMUNICATION SYSTEM

FIG. 2

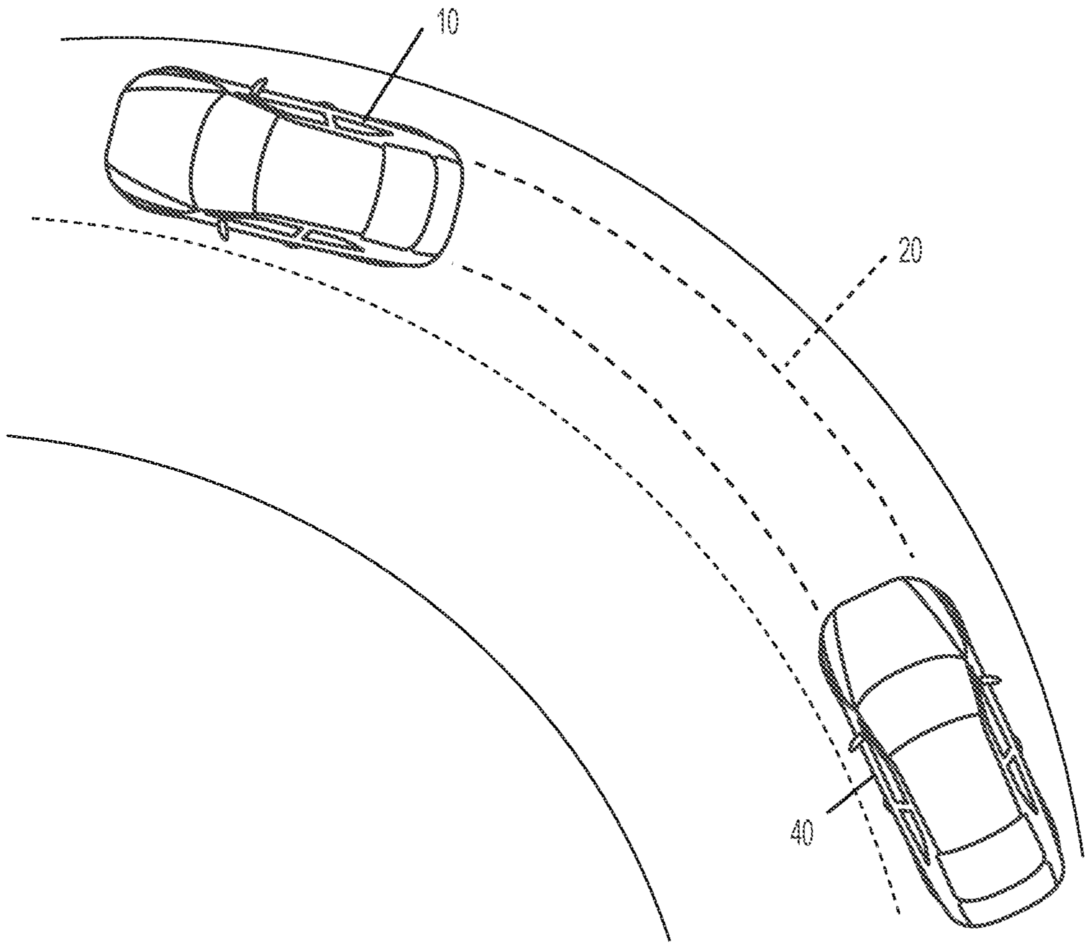


FIG. 3

# DRIVER ASSISTANCE SYSTEM FOR A VEHICLE

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13/919,483, filed Jun. 17, 2013, now U.S. Pat. No. 9,245,448, which is a continuation of U.S. patent application Ser. No. 12/483,996, filed Jun. 12, 2009, now U.S. Pat. No. 8,466,806, which is a continuation of U.S. patent application Ser. No. 12/058,155, filed Mar. 28, 2008, now U.S. Pat. No. 7,551,103, which is a continuation of U.S. patent application Ser. No. 11/735,782, filed Apr. 16, 2007, now U.S. Pat. No. 7,355,524, which is a continuation of U.S. patent application Ser. No. 11/108,474, filed Apr. 18, 2005, now U.S. Pat. No. 7,205,904, which is a continuation of U.S. patent application Ser. No. 10/209,173, filed on Jul. 31, 2002, now U.S. Pat. No. 6,882,287, which claims priority from U.S. provisional application Ser. No. 60/309,022, filed on Jul. 31, 2001, the disclosures of which are hereby incorporated herein by reference in their entireties.

## TECHNICAL FIELD OF INVENTION

This invention relates to object detection adjacent a motor vehicle as it travels along a highway, and more particularly relates to imaging systems that view the blind spot adjacent a vehicle and/or that view the lane adjacent the side of a vehicle and/or view the lane behind or forward the vehicle as it travels down a highway.

## BACKGROUND OF INVENTION

Camera-based systems have been proposed, such as in commonly assigned patent application Ser. No. 09/372,915, filed Aug. 12, 1999, now U.S. Pat. No. 6,396,397, the disclosure of which is hereby incorporated herein by reference, that detect and display the presence, position of, distance to and rate of approach of vehicles, motorcycles, bicyclists, and the like, approaching a vehicle such as approaching from behind to overtake in a side lane to the vehicle. The image captured by such vehicular image capture systems can be displayed as a real-time image or by icons on a video screen, and with distances, rates of approach and object identifiers being displayed by indicia and/or overlays, such as is disclosed in U.S. Pat. Nos. 5,670,935; 5,949,331 and 6,222,447, the disclosures of which are hereby incorporated herein by reference. Such prior art systems work well. However, it is desirable for a vehicle driver to have visual access to the full 360 degrees surrounding the vehicle. It is not uncommon, however, for a vehicle driver to experience blind spots due to the design of the vehicle bodywork, windows and the rearview mirror system. A blind spot commonly exists between the field of view available to the driver through the exterior rearview mirror and the driver's peripheral limit of sight. Blind Spot Detection Systems (BSDS), in which a specified zone, or set of zones in the proximity of the vehicle, is monitored for the presence of other road users or hazardous objects, have been developed. A typical BSDS may monitor at least one zone approximately one traffic lane wide on the left- or right-hand side of the vehicle, and generally from the driver's position to approximately 10 m rearward. The objective of these systems is to provide the driver an indication of the presence of other road users located in the targeted blind spot.

Imaging systems have been developed in the prior art, such as discussed above, to perform this function, providing a visual, audio or tactile warning to the driver should a lane change or merge maneuver be attempted when another road user or hazard is detected within the monitored zone or zones. These systems are typically used in combination with a system of rearview mirrors in order to determine if a traffic condition suitable for a safe lane change maneuver exists. They are particularly effective when the detected object is moving at a low relative velocity with reference to the detecting vehicle, since the detected object may spend long periods of time in the blind spot and the driver may lose track of surrounding objects. However, prior art systems are inadequate in many driving conditions.

Known lane departure warning systems typically rely on visually detecting markers on the road on both sides of the vehicle for lane center determination. These markers must be fairly continuous or frequently occurring and generally must exist on both sides of the vehicle for the lane center position to be determined. Failure to detect a marker usually means failure of the departure-warning algorithm to adequately recognize a lane change event.

## SUMMARY OF THE INVENTION

The present invention provides a Lane Change Aid (LCA) system wherein the driver of a motor vehicle traveling along a highway is warned if any unsafe lane change or merge maneuver is attempted, regardless of information available through the vehicle's rearview mirror system. The Lane Change Aid (LCA) system of the present invention extends the detection capability of the blind spot detection systems of the prior art.

A vehicle lane change aid system, according to an aspect of the invention, includes a detector that is operative to detect the presence of another vehicle adjacent the vehicle, an indicator for providing an indication that a lane change maneuver of the equipped vehicle may affect the other vehicle and a control receiving movement information of the equipped vehicle. The control develops a position history of the equipped vehicle at least as a function of the movement information. The control compares the detected presence of the other vehicle with the position history and provides the indication when a lane change maneuver may affect the other vehicle.

A vehicle lane change aid system, according to an aspect of the invention, includes an imaging device for capturing lane edge images and a control that is responsive to an output of said imaging device to recognize lane edge positions. The control is operable to distinguish between certain types of lane markers. The control may distinguish between dashed-lane markers and non-dashed-line markers.

A vehicle lane change aid system, according to an aspect of the invention, includes an imaging device for capturing lane edge images and a control that is responsive to an output of said imaging device to recognize lane edge positions. The control is operative to determine that the vehicle has departed a lane. The control may notify the driver that a lane has been departed. The control may further include oncoming vehicle monitoring and side object detection.

A vehicle lane change aid system, according to an aspect of the invention, includes a forward-facing imaging device for capturing images of other vehicles and a control that is responsive to an output of said imaging device to determine an imminent collision with another vehicle. The control may include a wireless transmission channel to transmit a safety warning to the other vehicle. The control may also activate a horn or headlights of the equipped vehicle of an imminent collision.

These and other objects, advantages and features of this invention will become apparent upon review of the following specification in conjunction with the drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1A-1C** are top plan views illustrating a vehicle equipped with a lane change aid system, according to the invention, traveling a straight section of road;

FIG. **2** is a block diagram of a lane change aid system, according to the invention; and

FIG. **3** is a top plan view illustrating a vehicle equipped with a lane change aid system traveling a curved section of road.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings and the illustrative embodiments depicted therein, a Lane Change Aid (LCA) system **12** of the present invention as illustrated with a vehicle **10** includes a control **18** and an indicator and/or display system **16** that warns a vehicle operator if an intended, or attempted, lane change maneuver could cause an approaching rearward vehicle to brake and decelerate at an unsafe rate, or that otherwise constitutes a highway hazard. In Lane Change Aid (LCA) system **12**, the dimension, in the direction of travel, of a zone **20** to be monitored may be calculated based on an assumed maximum relative velocity between a detecting vehicle and an approaching rearward vehicle, and a safe braking and deceleration assumption. Depending on the assumptions made, the required detection zone may vary in length, such as extending rearward from 50 to 100 m, or more. At 100 m, the road curvature behind the vehicle may have a significant impact on the position of the lane of the detected vehicle, relative to the detecting vehicle. Since it is important to know which lane an approaching rearward vehicle is in, relative to the detecting vehicle, in order to provide the driver an appropriate warning, and to avoid many false warnings, the Lane Change Aid (LCA) system **12** includes developing and maintaining a lane position history **20** for the space rearward of the detecting vehicle.

By combining distance traveled with steering angle, the detecting vehicle path may be plotted. Details of the last approximately 100 m traveled are of value for lane change aids and may be stored by the Lane Change Aid (LCA) system. Data may be stored by several methods including the method described below.

Vehicle speed information in the Lane Change Aid (LCA) system **12** is typically derived from a wheel rotation sensor signal **24**, which consists of a number of pulses, n, per revolution of the road wheel, and available on a vehicle data bus **26**, such as a CAN or LIN bus, or the like. Sensing and signal detail may vary depending on vehicle design, but for any particular design, a distance, d, traveled between pulses can be established. Also, as each pulse is detected, the current value of the steering angle, $+/-\alpha$, determined by a steering angle encoder **22** may be read from vehicle data bus **26**. Again, the sensing and signal detail may vary depending on vehicle design, but, for any particular vehicle design, an effective turning radius, r, for the vehicle can be established.

Image-based blind spot detection devices and lane change aids, generally shown at **14**, are but two of a variety of sensing devices and technologies and devices suitable for the purpose of monitoring the local environment in which a vehicle operates. Radar, infrared, sonar, and laser devices are all capable of interrogating the local environment for the presence of other road users or obstacles to be avoided. GPS systems can accurately determine the vehicle position on the earth's surface, and map data can provide detailed information of a mobile local environment. Other wireless communication systems **28** such as short-range wireless communication protocols, such as BLUETOOTH, can provide information such as the position of road works, lane restrictions, or other hazards, which can be translated by on-board vehicle electronics into position data relative to the vehicle position. Lane Change Aid (LCA) system **12** may integrate all the available information from a multiplicity of sensors including non-image-based detectors **14*b***, such as a radar sensor, such as a Doppler radar sensor, and at least one image-based detector **14*a*** such as a CMOS video camera imaging sensor, and converts the various sensor outputs into a single database with a common format, so that data from various sources, such as a Doppler radar source and a video camera source, may be easily compared, combined and maintained.

Consider a spherical space of radius R, and center $(x, y, z)=(0, 0, 0)$ in Cartesian coordinates or $(r, \theta, \beta\square=(0,0,0))$ in polar coordinates. It is convenient to describe the space in both coordinate systems since several operations will be used to fill the data space and to maintain it and a choice of systems allows for efficient computation methods. Let the center of this space (0, 0, 0) be at the center of the vehicle's rear axle, or nominal rear axle described by the line which passes through the center of the two rear non-steering wheels. Let the horizontal centerline of the vehicle, in the primary direction of travel, lie on (x, 0, 0), such that positive x values describe the space forward of the center of the vehicle's rear axle. Let the rear axle coincide with (0, y, 0), such that positive values of y describe the space to the right of the vehicle centerline when looking forward. (R, 90, 0) describes the positive y axis. Let positive z values describe the space above the centerline of the rear axle. (R, 0, 90) describes the positive z axis. This "sphere of awareness" **20** moves with the vehicle as it moves through space and provides a common frame of reference for all sensed or otherwise derived data concerning the vehicle's local environment.

For the purpose of storing vehicle path data, which may be used to improve the performance of lane change aid **12**, the discussion may be simplified by considering only the horizontal plane. The use of polar coordinates simplifies operations used in this application. The first data point, as the vehicle starts with no history, is at point (0, 0). The steering angle is read from the data bus and stored as $\alpha_0$. When wheel rotation pulse, $p_1$ is detected, steering angle $\alpha_1$ is recorded. Since the distance traveled between wheel pulses is known to be d, a new position for the previous data point can be calculated as $([2(1-\text{Cos}\ \alpha_0)]^{1/2}, (180+\alpha_0))$. This point is stored and recorded as historical vehicle path data. When pulse $p_2$ is detected, the above calculation is repeated to yield $([2(1-\text{Cos}\ \alpha_1)]^{1/2}, (180+\alpha_1))$ as the new position for the previous data point. This requires the repositioning of the original data to $([2(1-\text{Cos}\ \alpha_0)]^{1/2}+[2(1-\text{Cos}\ \alpha_1)]^{1/2}, [(180+\alpha_0)+\alpha_1])$. This process is continued until the distance from the vehicle, R, reaches the maximum required value, such as 100 m in the case of a lane change aid. Data beyond this point is discarded. Thus, a continuous record of the vehicle path for the last 100 m, or whatever distance is used, may be maintained. By maintaining a running record of the path traveled, rearward approaching vehicles detected by a lane change aid image analysis system may be positioned relative to that path as can be seen by comparing the other vehicle **40** in FIGS. **1**B and **1**C. In FIG. **1**B, other vehicle **40** is overlapping zone **20** so an indication of potential conflict may be delayed or discarded. In FIG. **1**C, the other vehicle **40** is moving outside of other vehicle **40** and in a blind spot of vehicle **10** so an indication of potential conflict would be given to the driver with indicator **16**. Thus, a determination may be made if the approaching vehicle is in the same, adjacent or next but one lane, etc. By this means, the number of inappropriate or unnecessary warnings may be reduced.

Lane change aid system **12** may include a controller, such as a microprocessor including a digital signal processor microcomputer of CPU speed at least about 5 MIPS, more preferably at least about 12 MIPS and most preferably at least about 30 MIPS, that processes inputs from multiple cameras **14***a* and other sensors **14***b* and that includes a vehicle path history function whereby, for example, an object, such as a rear-approaching car or motorcycle or truck, or the like, is selected and its presence highlighted to the driver's attention, such as by icons on a dashboard or interior mirror-mounted display, based on the recent history of the side and rear lanes that the host vehicle equipped with the controller of this invention has recently traveled in. An example is over a previous interval of about 60 seconds or less, or over a longer period such as about 3 minutes or more. The vehicle path history function works to determine the lane positioning of an approaching other vehicle, and whether the host vehicle is traveling on, or has recently traveled on, a straight road as illustrated in FIGS. **1**A, **1**B and **1**C, or a curved road portion as illustrated in FIG. **3**.

Control **18** may comprise a central video processor module such as is disclosed in commonly assigned provisional patent application Ser. No. 60/309,023, filed Jul. 31, 2001, and utility patent application filed concurrently herewith, now U.S. patent application Ser. No. 10/209,181, filed Jul. 31, 2002, and published Feb. 6, 2003 as U.S. Publication No. US 2003/0025793, the disclosures of which are hereby incorporated herein by reference. Such video processor module operates to receive multiple image outputs from vehicle-mounted cameras, such as disclosed in commonly assigned patent application Ser. No. 09/793,002, filed Feb. 26, 2001, now U.S. Pat. No. 6,690,268, the disclosure of which is hereby incorporated herein by reference, and integrates these in a central processing module to allow reaction to the local vehicle environment. Optionally, and when bandwidth limitations exist that limit the ability to send raw image data, particularly high-resolution images, from a remote camera to a central processing unit across robust transmission means, such as a fiber-optic cable or a high-density wireless link, distributed processing can occur, at least local to some of the image capture sensors. In such an at least partial distributed processing environment, the local processors are adapted to preprocess images captured by the local camera or cameras and any other device such as a Doppler radar sensor viewing a blind spot in an adjacent side lane and to format this preprocessed data into a standard format and transmit this standard formatted data. The data can be transmitted via a wired network or a wireless network or over a vehicle bus system, such as a CAN bus and/or a LIN bus, or the like, to the central processor for effective, centralized mapping and combination of the total local environment around the vehicle. This provides the driver with a display of what is happening in both the right and the left side lanes, and in the lane that the host vehicle is itself traveling in.

In this regard, the vehicle can be provided with a dedicated bus and central processor, as described above, for providing a vehicle environment awareness, which can be both internal such as might be provided by interior cabin or trunk monitors/sensors that determine occupant presence, head position and/or movement, eye movement, air bag deployment, microphone aiming, seat positioning, air conditioning and/or heating targeting, audio controls, and the like, or can be external to the vehicle such as in blind spot detecting or lane change detecting. The present invention includes provision of an automatic environment awareness function that comprises automatic gathering of sensor-derived data collection and transmission in a standard format via a vehicle bus network, said data including data relating to the vehicle environment such as the exterior environment, for example, the presence of rear-approaching traffic in side and rear lanes to the host vehicle as captured by rear-facing CMOS or CCD cameras on the side of the host vehicle, such as included in a side view mirror assembly on either or both sides of the host vehicle and/or as detected by a rear lane/side lane-viewing Doppler radar sensor, and preferably includes processing in a central video processing unit.

The information relating to the external environment can be relayed/displayed to the driver in a variety of ways. For example, a blind-spot vehicle-presence indication can be displayed adjacent the exterior mirror assembly, such as inside the vehicle cabin local to where the exterior mirror assembly is attached to the vehicle door so that the indicator display used, typically an LED flashing light source, or the like, is visible to the driver but not visible to any traffic/drivers exterior to the vehicle, but is cognitively associated with the side of the vehicle to which that particular nearby exterior mirror is attached to, and as disclosed in commonly assigned U.S. Pat. Nos. 5,786,772; 5,929,786 and 6,198,409, the disclosures of which are hereby incorporated herein by reference. Optionally, a vibration transducer can be included in the steering wheel that trembles or otherwise vibrates to tactilely warn the driver of the presence of an overtaking vehicle in a side lane that the driver is using the steering wheel to turn the driver's vehicle into where an overtaking or following vehicle may constitute a collision hazard. Hazard warnings can be communicated to the driver by voice commands and/or audible warnings, and/or by heads-up-displays. The coordinate scheme for data collection of the present invention enables an improved blind spot and/or lane change detection system for vehicles and particularly in busy traffic on a winding, curved road.

The present invention includes the fusion of outputs from video and non-video sensors, such as, for example, a CMOS video camera sensor and a Doppler radar sensor, to allow all-weather and visibility side object detection. The present invention includes the fusion of outputs from video and non-video sensors, such as, for example, a CMOS video camera sensor and a Doppler radar sensor, to allow all-weather and visibility side object detection. The present invention can be utilized in a variety of applications such as disclosed in commonly assigned U.S. Pat. Nos. 5,670,935; 5,949,331; 6,222,447; 6,201,642; 6,097,023; 5,715,093; 5,796,094 and 5,877,897 and commonly assigned patent application Ser. No. 09/793,002 filed Feb. 26, 2001, now U.S. Pat. No. 6,690,268, Ser. No. 09/372,915, filed Aug. 12, 1999, now U.S. Pat. No. 6,396,397, Ser. No. 09/767,939, filed Jan. 23, 2001, now U.S. Pat. No. 6,590,719, Ser. No. 09/776,625, filed Feb. 5, 2001, now U.S. Pat. No. 6,611,202, Ser. No. 09/799,993, filed Mar. 6, 2001, now U.S. Pat. No. 6,538,827, Ser. No. 09/493,522, filed Jan. 28, 2000, now U.S. Pat. No. 6,426,492, Ser. No. 09/199,907, filed Nov. 25, 1998, now U.S. Pat. No. 6,717,610, Ser. No. 08/952,026, filed Nov. 19, 1997, now U.S. Pat. No. 6,498,620, Ser. No. 09/227,344, filed Jan. 8, 1999, now U.S. Pat. No. 6,302,545, International Publication No. WO 96/38319, published Dec. 5, 1996, and International Publication No. WO 99/23828, published May 14, 1999, the disclosures of which are collectively incorporated herein by reference.

Lane change aid system **12** may include a lane marker type recognition algorithm, or capability **32**. Lane marker type recognition capability **32** utilizes classifying lane markers as one of many specific types for the purpose of interpreting the original purpose of the lane marker and issuing reliable and meaningful warnings based on this interpretation. As an example, a double line on the left side of a left-hand drive vehicle typically indicates a no-encroachment zone or no passing zone. A solid line with adjacent dashed line will indicate either an ability to pass safely if the dashed line is on the near side of the solid line or a do not encroach zone if the dashed line is on the far side of the solid line. Road edges can be distinctly recognized and classified as no-encroachment zones. Conversely, dashed lines may have no significance to lane departure warning algorithms since they merely indicate lane edge positions. Recognizing dashed lines as such gives the ability to not initiate nuisance warnings. The recognition algorithm can further be enhanced by recognizing road features when lane markers are too weak or missing. Features, such as curbs, road seams, grease or rubber slicks, road signs, vehicles in same, neighboring, and/or opposing lanes when recognized, could be used to interpret lane-vehicle positioning and issue intelligent warning alerts to the driver. Fewer false or nuisance type warnings with improved real warning functionality and speed can be realized with this improvement. Operation under difficult lighting and environmental conditions can be extended.

Note that collision avoidance functionality **34** can optionally be achieved using a forward-facing camera **14***a* in the present invention. For example, should the forward-looking camera detect an oncoming car likely to collide with the vehicle equipped with the present invention, or if another vehicle tries to pull in front of it, the system of the present invention can issue a warning (visual and/or audible) to one or both drivers involved. Such warning can be flash headlights and/or sound car horn. Similarly, the system can detect that the driver of the vehicle equipped with the present invention is failing to recognize a stop sign and/or a signal light, or some other warning sign and the driver can be warned visually, such as with a warning light at the interior mirror in the vehicle cabin, or audibly, such as via a warning beeper, or tactilely, such as via a rumble/vibration transducer that vibrates the steering wheel to alert the driver of a potential hazard.

System **12** may also include a lane departure warning algorithm, or system **36**. For example, when a left-hand drive vehicle equipped with system **10** is making a left-hand turn generally across a line on the road. System **36** can monitor for a lane crossing and combine it with detection of an oncoming vehicle. The system **12** may also calculate closing speed for warning of potential impact of closing vehicles.

Also, the vehicle can be provided on its front fender or elsewhere at the front of the vehicle with a side-looking camera as an image-based detector **14***a* operable to warn the driver when he/she is making a left turn across lanes of traffic coming from his/her left (left-side warning) and then again when he/she is about to enter traffic lanes with traffic coming from his right (right-side warning). While executing this turn, the system of the present invention may utilize the detection of the lane markers when the driver's car is about to enter the specific lane combined with oncoming vehicle detection as a means of predictive warning before he actually enters the danger zone.

System **12** is also capable of performing one or more vehicle functions **30**. For example, should the lane departure warning system **36** detect that the vehicle equipped with the system is intending to make or is making a lane change and the driver has neglected to turn on the appropriate turn signal indicators, then the system performs a vehicle function **30** of automatically turning on the turn signals on the appropriate side of the vehicle.

The lane departure warning system **36** of the present invention is operable to differentiate between solid and dashed lines and double lines on the road being traveled. Also, should the vehicle be equipped with a side object detection (SOD) system such as a Doppler radar unit or a camera vision side object detection system that detects the presence of overtaking vehicles in the adjacent side lane, then the SOD system can work in conjunction with the lane departure warning system such that as the lane departure system detects that the driver is making a lane change into a side lane when the SOD system detects an overtaking vehicle in that same side lane, then the driver is alerted and warned of the possible hazard, such as by a visual, audible and/or tactile alert.

As indicated above, the forward-facing camera can include stoplight or sign detection, and the system can further include a broadcast with wireless communication system **28** on a safety warning band when the forward-facing camera detects the stoplight or sign and determines the vehicle is not going to stop based on current speed and deceleration. This would warn crossing drivers of an unsafe condition. Such alerts can dynamically vary depending on road surface conditions (wet, snow, ice, etc.) as visually detected and determined by the forward-facing, road-monitoring camera. For example, wet or snowy roads would change the distance and/or speed at which it would warn based on camera vision recognition of stoplights and/or stop signs. When approaching a stoplight when it changes or the vehicle does not slow down for the light after the driver was warned, the system can blow the horn and/or flash the lights to warn vehicles at the stoplight of the oncoming vehicle. The car may also broadcast one of the safety alerts radar detectors pick up.

Changes and modifications in the specifically described embodiments can be carried out without departing from the principles of the invention, which is intended to be limited only by the scope of the appended claims, as interpreted according to the principles of patent law including the doctrine of equivalents.

The invention claimed is:

**1**. A driver assistance system for a vehicle, said driver assistance system comprising:

a forward facing camera disposed at or in a vehicle equipped with said driver assistance system, said forward facing camera having a field of view that, when the equipped vehicle is traveling on a road, encompasses the road ahead of and to the left of the equipped vehicle;

wherein the equipped vehicle is a left-hand drive vehicle;

a control disposed at or in the equipped vehicle and comprising an image processor;

wherein image data captured by said forward facing camera is processed by said image processor;

wherein said image processor processes data at a processing speed of at least about 30 MIPS;

wherein said control receives vehicle data relating to the equipped vehicle via a vehicle bus of the equipped vehicle, said vehicle data including vehicle speed and vehicle steering angle;

wherein, via processing by said image processor of image data captured by said forward facing camera, said control is operable to detect a road marking on the road being traveled by the equipped vehicle and to the left of the equipped vehicle;

wherein said image processor utilizes a lane marker type recognition algorithm to classify the detected road marking to be one of (i) a single solid line, (ii) a single dashed line and (iii) double lines;

wherein, responsive to classification by the lane marker type recognition algorithm of the detected road marking to be double lines and not to be either a single solid line or a single dashed line, (a) said control determines ability to pass safely to the left of the equipped vehicle when the double lines are determined to be a solid line and an adjacent dashed line with the adjacent dashed line being closer to the equipped vehicle than the solid line, and (b) said control determines a non-encroachment/no-passing zone to exist to the left of the equipped vehicle when the double lines are determined to be two solid lines, and (c) said control determines a non-encroachment zone to exist to the left of the equipped vehicle when the double lines are determined to be a solid line and an adjacent dashed line with the adjacent dashed line being farther from the equipped vehicle than the solid line.

**2**. The driver assistance system of claim **1**, wherein said forward facing camera views lane markers on the road being traveled by the equipped vehicle, and wherein said control, responsive to processing by said image processor of image data captured by said forward facing camera, determines a lane on the road being traveled by the equipped vehicle.

**3**. The driver assistance system of claim **1**, wherein, via processing by said image processor of image data captured by said forward facing camera, said control determines road curbs.

**4**. The driver assistance system of claim **1**, wherein said image processor processes image data from at least one other camera of the equipped vehicle, and wherein said other camera is located at an exterior sideview mirror assembly of the equipped vehicle.

**5**. The driver assistance system of claim **1**, wherein said control receives input from a global positioning system.

**6**. The driver assistance system of claim **1**, wherein, via processing by said image processor of image data captured by said forward facing camera, said control determines road seams.

**7**. The driver assistance system of claim **1**, comprising a radar sensor mounted at the equipped vehicle, wherein radar data from said radar sensor is received by said control and wherein image data and radar data are fused at said control.

**8**. The driver assistance system of claim **1**, wherein said vehicle bus comprises at least one of (a) a CAN bus of the equipped vehicle and (b) a LIN bus of the equipped vehicle.

**9**. The driver assistance system of claim **1**, wherein, via processing by said image processor of image data captured by said forward facing camera, said control determines at least one of (i) a wet road condition and (ii) a snowy road condition.

**10**. The driver assistance system of claim **1**, comprising a wireless communication system, wherein at least one of (i) information on road conditions is receivable at the equipped vehicle via said wireless communication system and (ii) said control is operable to transmit safety warnings via said wireless communication system.

**11**. The driver assistance system of claim **1**, wherein, responsive at least in part to processing of image data by said image processor, said control determines that the equipped vehicle may be in hazard of a collision.

**12**. A driver assistance system for a vehicle, said driver assistance system comprising:

a forward facing camera disposed at or in a vehicle equipped with said driver assistance system, said forward facing camera having a field of view that, when the equipped vehicle is traveling on a road, encompasses the road ahead of and to the left of the equipped vehicle;

wherein the equipped vehicle is a left-hand drive vehicle;

a control disposed at or in the equipped vehicle and comprising an image processor;

wherein image data captured by said forward facing camera is processed by said image processor;

wherein, via processing by said image processor of image data captured by said forward facing camera, said control is operable to detect a road marking on the road being traveled by the equipped vehicle and to the left of the equipped vehicle;

wherein said image processor utilizes a lane marker type recognition algorithm to classify the detected road marking to be one of (i) a single solid line, (ii) a single dashed line and (iii) double lines;

wherein said image processor processes image data from at least one other camera of the equipped vehicle, and wherein said other camera is located at the left side of the equipped vehicle;

wherein a radar sensor is mounted at the equipped vehicle;

wherein radar data from said radar sensor is received by said control;

wherein, responsive to classification by the lane marker type recognition algorithm of the detected road marking to be double lines and not to be either a single solid line or a single dashed line, (a) said control determines ability to pass safely to the left of the equipped vehicle when the double lines are determined to be a solid line and an adjacent dashed line with the adjacent dashed line being closer to the equipped vehicle than the solid line, and (b) said control determines a non-encroachment/no-passing zone to exist to the left of the equipped vehicle when the double lines are determined to be two solid lines, and (c) said control determines a non-encroachment zone to exist to the left of the equipped vehicle when the double lines are determined to be a solid line and an adjacent dashed line with the adjacent dashed line being farther from the equipped vehicle than the solid line; and

wherein, responsive at least in part to processing of image data by said image processor, said control determines the presence of traffic approaching in a lane to the left of the equipped vehicle.

**13**. The driver assistance system of claim **12**, wherein said control receives vehicle data relating to the equipped vehicle via a vehicle bus of the equipped vehicle, said vehicle data including vehicle speed and vehicle steering angle, and wherein said image processor processes data at a processing speed of at least about 30 MIPS, and wherein said other camera is located at an exterior sideview mirror assembly of the equipped vehicle.

14. The driver assistance system of claim 12, wherein said forward facing camera views lane markers on the road being traveled by the equipped vehicle, and wherein said control, responsive to processing by said image processor of image data captured by said forward facing camera, determines a lane on the road being traveled by the equipped vehicle.

15. The driver assistance system of claim 14, wherein, via processing by said image processor of image data captured by said forward facing camera, said control determines road curbs.

16. The driver assistance system of claim 12, wherein, via processing by said image processor of image data captured by said forward facing camera, said control determines at least one of (i) a wet road condition and (ii) a snowy road condition.

17. The driver assistance system of claim 16, wherein, responsive at least in part to processing of image data by said image processor, said control determines that the equipped vehicle may be in hazard of a collision.

18. The driver assistance system of claim 12, wherein, responsive at least in part to processing of image data by said image processor, said control determines the presence of traffic of rear-approaching traffic approaching the equipped vehicle in a lane to the left of the equipped vehicle.

19. A driver assistance system for a vehicle, said driver assistance system comprising:

a forward facing camera disposed at or in a vehicle equipped with said driver assistance system, said forward facing camera having a field of view that, when the equipped vehicle is traveling on a road, encompasses the road ahead of and to the left of the equipped vehicle;

wherein the equipped vehicle is a left-hand drive vehicle;

a control disposed at or in the equipped vehicle and comprising an image processor;

wherein image data captured by said forward facing camera is processed by said image processor;

wherein said forward facing camera views lane markers on the road being traveled by the equipped vehicle, and wherein said control, responsive to processing by said image processor of image data captured by said forward facing camera, determines a lane on the road being traveled by the equipped vehicle;

wherein said image processor processes image data from at least one other camera of the equipped vehicle and wherein said other camera is located at the left side of the equipped vehicle;

wherein a radar sensor is mounted at the equipped vehicle;

wherein radar data from said radar sensor is received by said control;

wherein said image processor utilizes a lane marker type recognition algorithm to classify a detected lane marker to be one of (i) a single solid line, (ii) a single dashed line and (iii) double lines;

wherein, responsive at least in part to processing of image data by said image processor and, responsive to classification by the lane marker type recognition algorithm of the detected lane marker to be double lines and not to be either a single solid line or a single dashed line, (a) said control determines ability to pass safely to the left of the equipped vehicle when the double lines are determined to be a solid line and an adjacent dashed line with the adjacent dashed line being closer to the equipped vehicle than the solid line, and (b) said control determines a non-encroachment/no-passing zone to exist to the left of the equipped vehicle when the double lines are determined to be two solid lines, and (c) said control determines a non-encroachment zone to exist to the left of the equipped vehicle when the double lines are determined to be a solid line and an adjacent dashed line with the adjacent dashed line being farther from the equipped vehicle than the solid line;

wherein, responsive at least in part to processing of image data by said image processor, said control determines the presence of traffic approaching in a lane to the left of the equipped vehicle; and

wherein, responsive at least in part to processing of image data by said image processor, said control determines that the equipped vehicle may be in hazard of a collision.

20. The driver assistance system of claim 19, wherein, via processing by said image processor of image data captured by said forward facing camera, said control determines road curbs.

21. The driver assistance system of claim 19, wherein, via processing by said image processor of image data captured by said forward facing camera, said control determines at least one of (i) a wet road condition and (ii) a snowy road condition.

22. The driver assistance system of claim 19, wherein image data and radar data are fused at said control.

23. The driver assistance system of claim 22, wherein said image processor processes data at a processing speed of at least about 30 MIPS, and wherein said control receives vehicle data relating to the equipped vehicle via a vehicle bus of the equipped vehicle, said vehicle data including vehicle speed and vehicle steering angle.

24. The driver assistance system of claim 19, wherein, via processing by said image processor of image data captured by said forward facing camera, said control is operable to detect a road marking on the road being traveled by the equipped vehicle and to the left of the equipped vehicle.

25. The driver assistance system of claim 24, wherein said control receives vehicle data relating to the equipped vehicle via a vehicle bus of the equipped vehicle, said vehicle data including vehicle speed and vehicle steering angle, and wherein said image processor processes data at a processing speed of at least about 30 MIPS.

26. The driver assistance system of claim 25, wherein said other camera is located at an exterior sideview mirror assembly of the equipped vehicle.

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